NuTools Mini-Workshop for the Applied Antineutrino Technology Community

22-24 July 2020

JUNO-TAO as a Precise Reactor Antineutrino Detector

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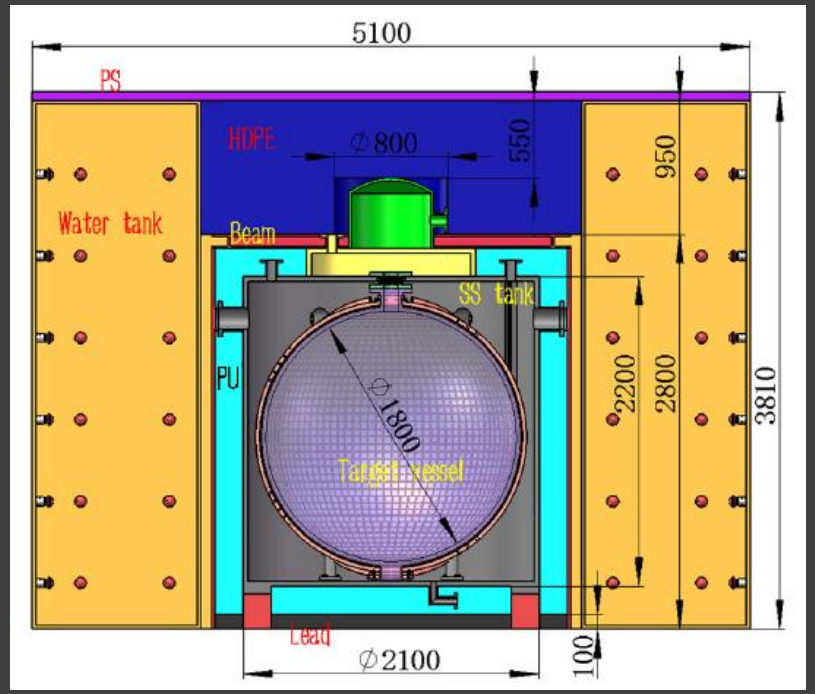
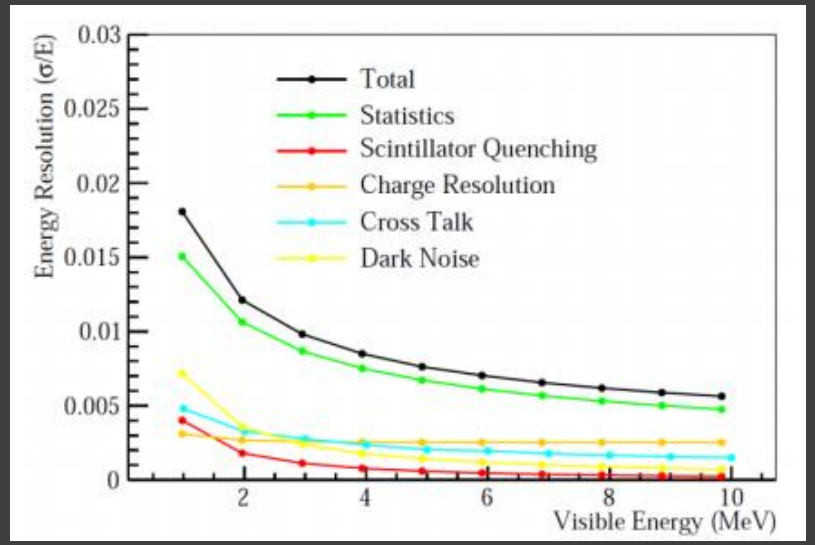
JUNO-TAO (Taishan Antineutrino Observatory)

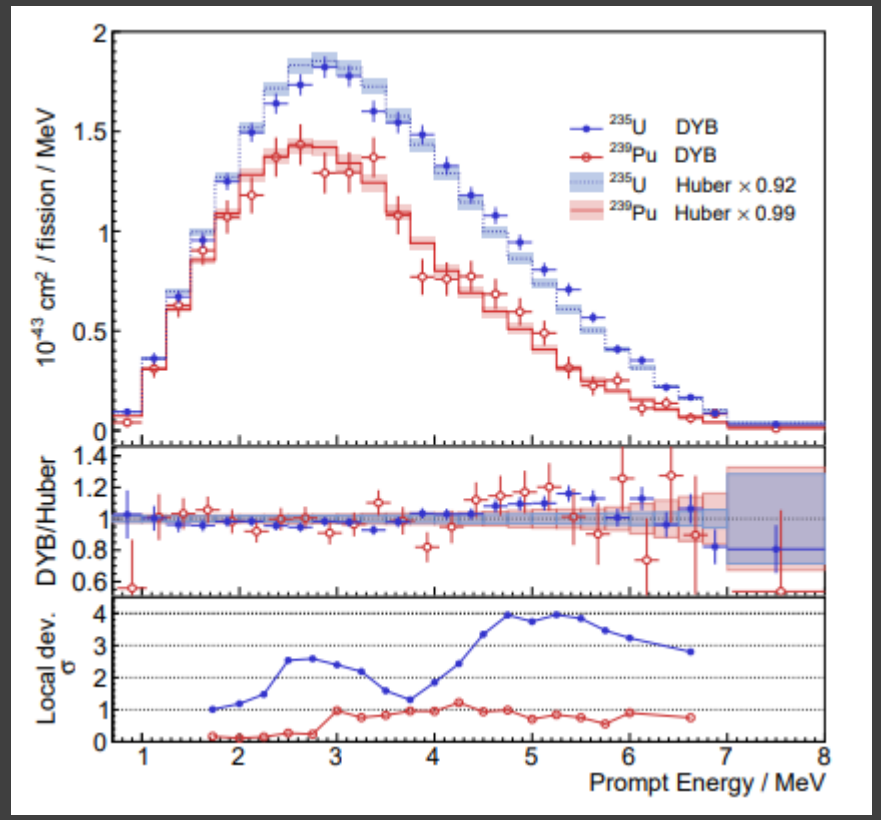
- A satellite experiment of JUNO experiment
- Physics goals
  - Provide model-independent reference spectrum for JUNO by measuring fine structure with sub-percent energy resolution in the major energy ranges
  - Provide a benchmark measurement to examine nuclear database and improve nuclear physics for knowledge of neutron-rich isotopes
  - As a demonstration of the technology for reactor monitoring and safeguard
- Conceptual design released (arXiv:2005.08745)
  - Optical sensor: 10 m^2 SiPM with QE=50%
  - 2.8 ton GdLS (FV mass 1 ton) at low temperature, -50^oC
  - 4500 p.e./MeV from MC simulation
  - 30 m from Taishan reactor
  - 2000 reactor antineutrinos/day with 50% efficiency
- Prototype will be tested at low. temperature w/o full SiPM
- Expected to start operation in 2022



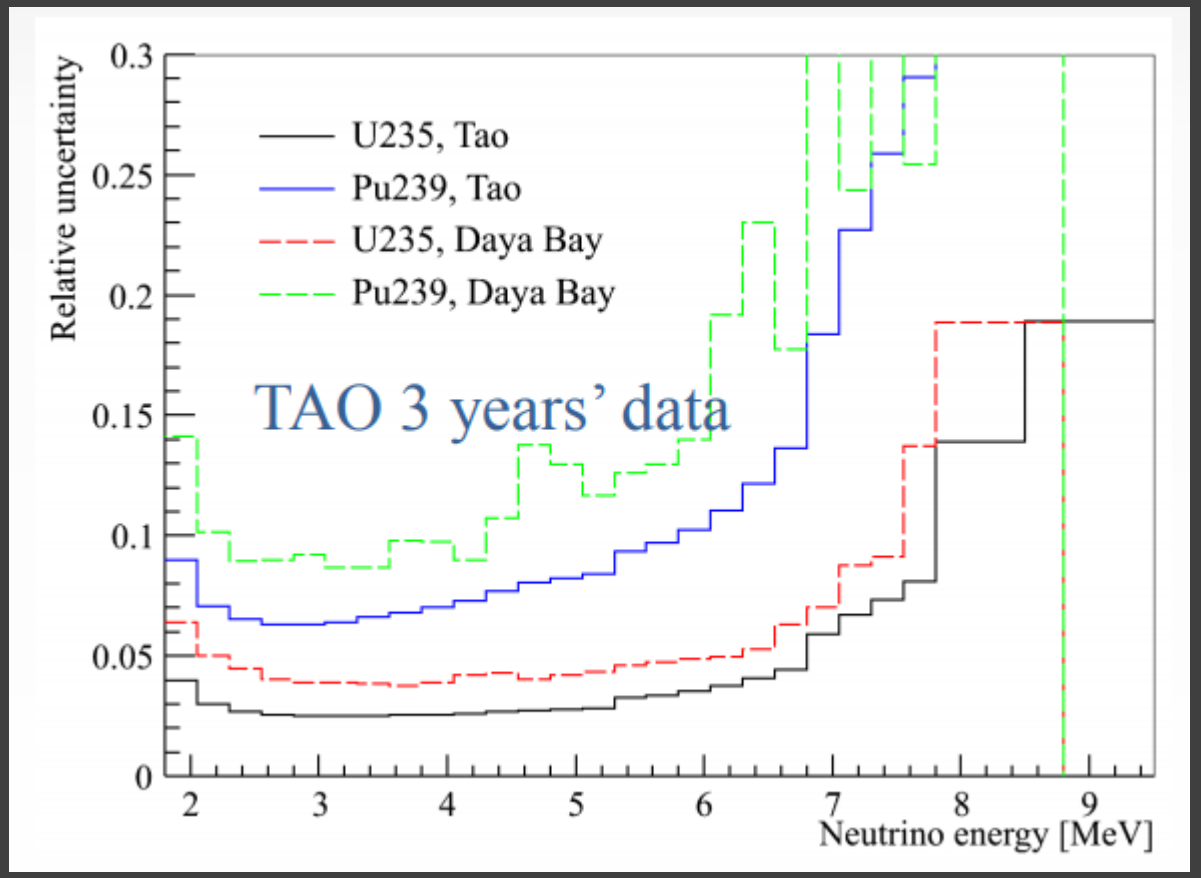


Reactor monitoring

- Evolution of antineutrino spectrum ➔ fissile content in reactor
- Determine the U235 and Pu239 antineutrino spectra



From Daya Bay



Compared with the Daya Bay results
(Phys.Rev.Lett. 123 (2019) no.11, 111801)

Perspectives of future applications

- Ton-level liquid scintillator detector is promising as an antineutrino tool with a budget of 1-2 million US$
- JUNO-TAO's budget is several times higher pursuing energy resolution.
- Challenge: background reduction with limited overburden
  - Short baseline is required to enhance antineutrino signal
  - Both shielding and veto are required to reduce the cosmic induced background
    - 1.2 meter water for JUNO-TAO
    - 1/3 of the surface muon flux with some overburden
  - Pulse shape discrimination technology is possible to reject fast neutron background with special liquid scintillator

Expected background in JUNO-TAO

Items	Values
IBD signal	2000 events/day
Muon rate	70 Hz/m^2
Fast neutron background before veto	1880 events/day
Fast neutron background after veto	$<$ 200 events/day
Signal from radioactivity	$<$ 100 Hz
Accidental background rate	$<$ 190 events/day
^{8}He/^{9}Li background rate	$\sim$ 54 events/day

Thanks